



**US Army Corps
of Engineers**
North Central Division

GREAT LAKES LEVELS

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The Great Mississippi River Flood of 1993

An unprecedented flood devastated large areas of the upper Mississippi River basin encompassing Minnesota, Wisconsin, Iowa, Illinois, and Missouri. The news media have dubbed this the Great Flood of 1993. That's actually an understatement. From the Quad Cities of Illinois and Iowa down past St. Louis, Missouri, this flood broke the record levels set by the major floods of 1973 and 1965. At St. Louis (Figure 1), only the flood of 1844 may have been more severe. It not only broke the records, but in some areas it was more than three feet higher than the previous record.

The extent of damage to public

and private property (Figure 2), business, industry, agriculture, transportation and flood protection works was unmatched by any other flood disaster in the United States. Highway, rail, and inland waterway transportation were paralyzed during and after this historic deluge. But it was not only levels that made this flood so disastrous, it was the duration of the record levels. In most areas, the river stayed at extremely high levels for weeks, saturating and severely testing the levees along the river. The magnitude and duration of this flood caused the following estimated damages: a total of \$11 billion (includes \$6.5 billion in crop

damages); 20 million acres of farmland damaged; 47 lives lost; 74,000 people evacuated; 45,000 homes damaged; 39 out of 229 federal levees damaged; 164 out of 268 non-federal levees damaged; 879 out of 1,079 private levees damaged; and, about 200 pumping stations disabled, including a major water treatment plant in Des Moines, Iowa, that disrupted service for nearly three weeks.

The North Central Division is responsible for the areas of the Mississippi River basin from just below Hannibal, Missouri to its headwaters; the Lower Mississippi Valley Division takes over downstream of Hannibal for the

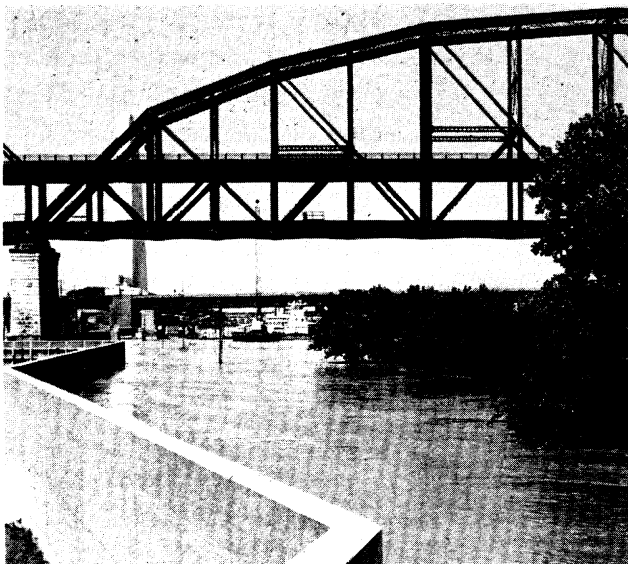


Figure 1. St. Louis



Figure 2. Typical Flood Scene

remainder of the main stem of the Mississippi River as it flows to the Gulf of Mexico. The Missouri River Division encompasses the Missouri River from its headwaters to its mouth, above St. Louis, with the Mississippi.

The flooding occurred in these three division boundaries. Within North Central Division flooding occurred in our St. Paul and Rock Island districts. In the Lower Mississippi Valley Division nearly all the flooding occurred within St. Louis district, with only a small portion of the Memphis district experiencing flooding. Finally, within the Missouri River Division, the majority of flooding occurred in the Kansas City district, with some also occurring in the Omaha district. Much of our descriptions of the flood that follows occurred within the North Central Division boundaries.

Precipitation

The midwest experienced heavy precipitation during the spring and

summer of this year. The soil moisture content in the upper Mississippi River basin was already high in the spring and most of the precipitation thereafter contributed to the runoff. The area from southeastern South Dakota to eastern Kansas experienced twice the average precipitation in May. A rare combination of meteorologic patterns produced a convergence zone over the upper midwest between the warm, moist air from the Gulf of Mexico and the cooler, drier air from Canada (Figure 3). This weather pattern stalled in the area until the end of July causing unusually heavy precipitation throughout the region. According to U.S. Geological Survey Circular 1120-B, precipitation in the Upper Mississippi River Basin, January 1 through July 31, 1993: "Monthly precipitation data at 10 weather station locations in the flood-affected area were used to illustrate precipitation patterns and amounts. In 1993, all 10 of the selected locations received greater than the normal (1961-90)

precipitation for January through June, 8 received more than 200 percent of the normal July rainfall; and 3 received from about 400 to 650 percent of the normal rainfall for July. May through July 1993 was the wettest or nearly the wettest such period on record at many locations in the flooded area. Of the 10 locations, 6 received more rain in the first 7 months of 1993 than is generally received in a year" (Figure 4).

Flooding in Minnesota and Wisconsin

This flood started in the Minnesota River, which drains southern Minnesota before joining the Mississippi River at St. Paul. Starting in late March, a series of storms brought heavy rainfall to the region. These rains saturated the soil and the Minnesota River was out of its banks and into towns and farm houses. While this flooding caused millions of dollars in damages, it was only a small precursor of what was to

come. Soon, the floodwaters of the Minnesota River reached the Mississippi River at St. Paul. This was not a record flood yet, but it was the highest level St. Paul had seen in any summer month. Partly because of the St. Paul Flood Control Project, the flooding was only minor there. The flood peaked at St. Paul on June 26th. Four days later it peaked at Prairie du Chien, Wisconsin. Along the way, cities such as Winona, Minnesota, and Guttenberg, Iowa, were spared damages because of Corps' floodwalls.

Prairie du Chien, Wisconsin, sits on a low, flat island in

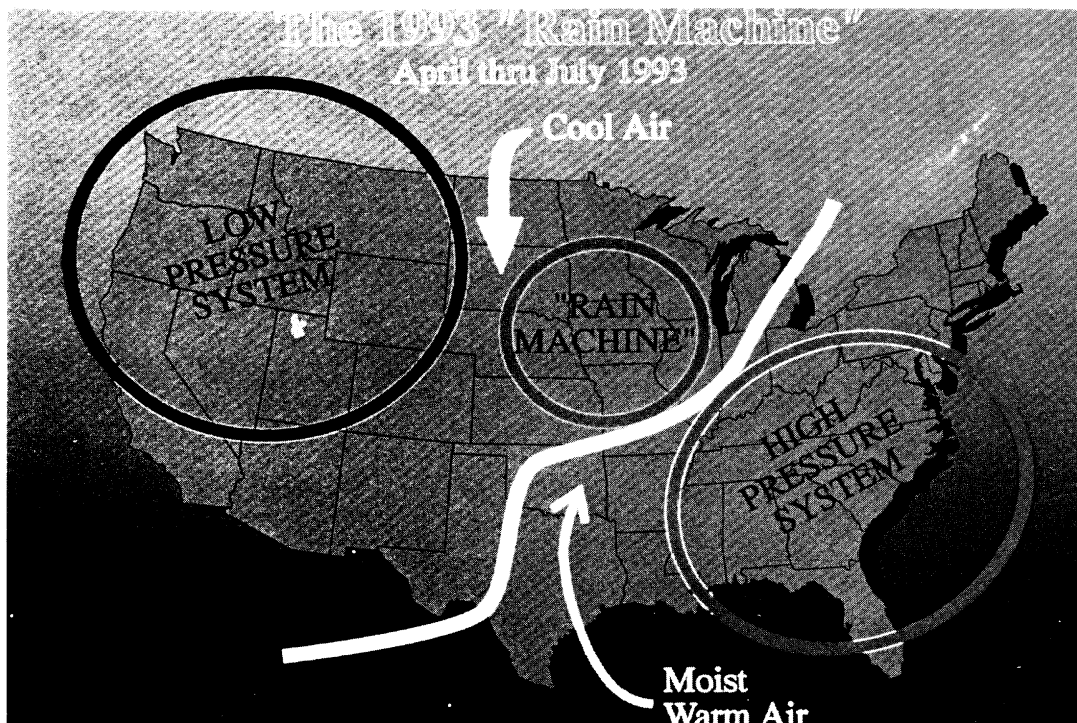


Figure 3. The 1993 "Rain Machine"

the middle of the Mississippi River. When the Corps examined Prairie du Chien flood problems in the late 1970s, it decided on an innovative course of action. Rather than try to keep flood waters out of the houses, the Corps moved some of the houses to keep them out of the way of the flood. Because of this partial evacuation of the lowest areas, this year's flooding had minor affects in the area.

It should be noted that the land-use management and non-structural flood control alternatives are considered first whenever the Corps begins a flood control study. The Corps also disseminates technical information on the best way to floodproof existing structures already in the floodplain. The Corps' experience at Prairie du Chien was a forerunner to subsequent studies and findings in other floodplains, e.g., the International Joint Commission's Great Lakes Levels Reference Study. The Reference Study also examined and

recommended the use of flood proofing because of the high costs of structural measures in comparison to estimated flood damages prevented.

Flooding In Iowa And Illinois

When the flood crest reached the Quad Cities, it developed national media interest. On July 9th, it broke a record that had lasted almost thirty years. The area's minor league baseball park was under water and many businesses in Davenport, Iowa were flooded throughout most of July.

The area downstream of the Quad Cities is primarily rural and agricultural. Much of the Mississippi River is lined with earthen levees that were built to allow farmers to till the rich soil behind them. In the early part of this century, the farmers formed cooperatives, now generally called drainage districts, to build these levees. Although the levees were originally built to protect only farmland, towns and industry grew up in the area protected by the levees.

Also, the Corps became involved over the years in strengthening and raising some of these levees, especially when the 9-foot navigation project was constructed and the navigation

responsibility. The Corps has a program that encourages the local entities to keep their levees well maintained by guaranteeing to rehabilitate levees damaged by floods.

These agricultural levees were no match for this flood. Most were only built to withstand a 25- or 50-year flood. Flood severity is measured in terms of the relative likelihood that a certain level flood will occur in any given year. For example, the 25-year flood has a 4% chance of occurring in any given year. Since this summer's flood was generally in excess of a 500-year (0.2%) event in some locations, starting from Hannibal down to near St. Louis, that is why many of the agricultural levees were overtopped or breached. These levees held at river stages beyond their design level as many were raised by emergency work to hold back more water. Of the 16 Federal levees between the Quad Cities and Hannibal, Missouri, 9 levees were over topped by the flood waters. Quincy, Illinois, had a levee breach that caused a particularly large amount of economic damage. On July 16th, a drainage district levee gave way, and flood waters quickly filled behind 5 miles of levee, including the ramp to the last open Mississippi River bridge for a 200-mile stretch of the river (law enforcement authorities have charged an individual with deliberate sabotage of this levee).

While earthen agricultural levees are typical in most parts of this region, the Corps has constructed flood walls and levees to protect the larger towns such as Rock Island, Bettendorf, and Quincy, Illinois and Hannibal, Missouri. The Hannibal Project is particularly noteworthy (Figure 5). Many of the houses that Mark Twain wrote about in his famous novels are quite close to the river and very flood

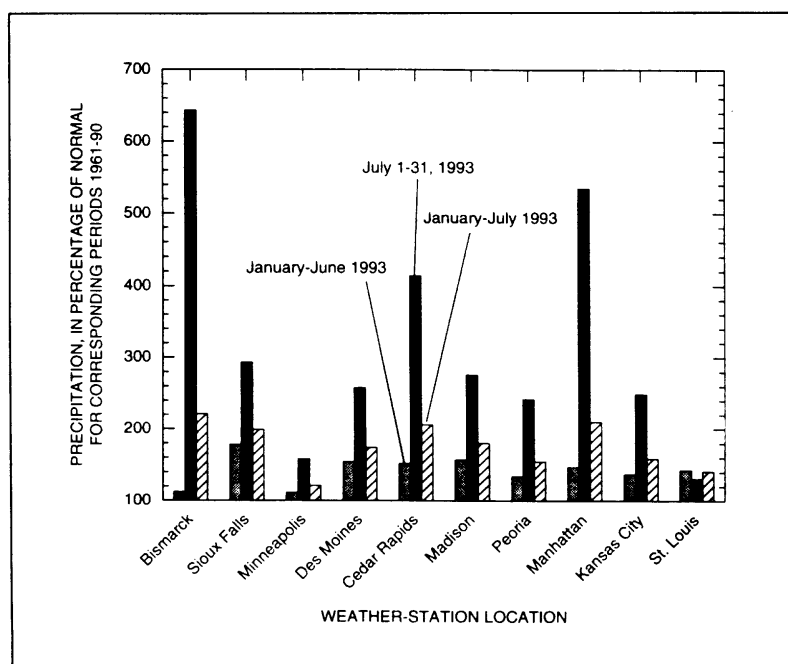


Figure 4. Seasonal Precipitation

pools were formed. Maintenance, however, has remained a local

prone. This flood forced the Corps to quickly add a three-foot extension on the top of the newly constructed floodwall (Figure 6). The new project held, leaving the historic treasures intact.

Flooding in Missouri

After peaking in the Quincy/Hannibal area during the third week in July, the flood peak passed on downstream towards St. Louis. The results were much the same as the upper part of the river. Most of the agricultural levees were overcome by the flood, but the Corps floodwalls at St. Louis kept the downtown area dry.

Since the Missouri River was also flooding, it worsened the situation for the region downstream of the Missouri-Mississippi confluence. At one point, the Missouri River overcame dikes in this area and actually cut a new channel to the Mississippi River.

Corps Locks

The Corps operates 29 locks and dams on the Mississippi River between Minneapolis-St. Paul and St. Louis. These maintain a nine-foot depth for barge traffic up and down the river during periods of low flow. They have no control over flood waters. At most of the locks below Dubuque, Iowa, the flood waters washed over the lock walls and flooded the control building (Figure 7). Navigation was, of course, impossible. As soon as the waters receded, intense efforts were made to get the facilities operational, but the barge traffic was suspended from late June until mid-August, costing the shipping companies and barge operators millions of dollars. Other forms of shipping were also disrupted as railroad lines were washed out and bridge closures caused truck traffic to be rerouted.

As many of you may recall, we had similar disruptions to shipping

(albeit to a much lesser extent) earlier this year on the St. Lawrence River due to extreme high water conditions on Lake Ontario. The other Great Lakes' shipping operations were not affected.

Effects on the Great Lakes

What would have happened if the wet weather had continued on the Great Lakes to the same extent that it occurred on the Mississippi River basin? We did some rough estimates based on preliminary data.

In June, Lake Superior was 1 inch above its long-term average level. If its basin received the rain the midwest did, the lake could have risen to a level 5 inches higher than actually occurred in August. This would have had relatively minor consequences in terms of damage and/or inconvenience to shoreline owners and recreational boaters. The effect on Lakes Michigan-Huron would also have been small, due to the immense size of these upper lakes. Lake Erie could have risen by about 16 inches. This would start to have some impact as docks start to go under water and shoreline owners face an increased risk of erosion and flooding damage. The biggest effect by far would have been on Lake Ontario as it was already in trouble earlier in the year. Such rains could have caused a 17-inch higher level which would have broken the monthly record levels from July and August and possibly further into the fall. This level would have submerged docks, denying access to the lake for many recreational boaters. If the levels had continued into the fall storm season, disastrous flooding and erosion could easily have occurred.



Figure 5. Hannibal, Missouri

Corps' 1993 Great Flood Fight

The Corps distributed almost 31 million sand bags and miles of plastic sheeting to help local communities protect themselves. The Corps' engineers were stationed up and down the river dispensing critical technical assistance. In most cases this involved advising local drainage districts in the best way to shore up and raise their levees as the flood waters rose.

While the Mississippi River locks and dams are not usable for flood control, the Corps' North Central Division has three large flood control dams in Iowa that played a key role in mitigating the damage caused by this flood. These are the Saylorville and Red Rock Reservoirs on the Des Moines River and Coralville Reservoir on the Iowa River. The Des Moines and Iowa Rivers are major tributaries to the Mississippi River and their drainage basins received some of the heaviest precipitation during this flood.

This precipitation quickly filled the reservoirs and threatened to drastically reduce their ability to provide future flood control storage. For the first time since its construction, water went over the emergency spillway at Coralville Reservoir. This was the third and fourth times for emergency spillway flow at Saylorville Reservoir. As the waters reached the top of these dams, the Corps had to make some careful decisions about the amount of water released. As with Lake Ontario this year, when the International St. Lawrence River Board of Control needed to balance flooding problems upstream and downstream, balancing among the various interests in the problem areas was required for these three reservoirs.

When water spills over the emergency spillways, it combines with the controlled outlet flow. Of course, these dams prevented millions of dollars in flood damages. For example, if Saylorville Dam had

never been constructed, vast portions of the City of Des Moines would have been underwater. Corps' hydrologists have calculated that if our three dams in Iowa had not been there to retain much of the flood water, the Mississippi River crest would have been about two feet higher at Quincy, Illinois, and 18-inches higher at Hannibal, Missouri. That much more water would have had disastrous consequences.

Unfortunately, the City of Des Moines was a victim of this flood, as its water treatment plant was flooded out, suspending water services to a quarter million people. The water treatment plant was flooded on 11 July by the Raccoon River, which enters the Des Moines River downstream of Saylorville Dam. Thus, there was no control over the flooding at the water treatment plant. Once President Clinton declared Des Moines a disaster, the Corps was called upon by the Federal Emergency Management Agency (FEMA) to

provide drinking water and put the water treatment plant back in operation as soon as possible.

The first action involved the distribution of about 105 million gallons of water per day to the nearly 300,000 people affected. Within 48 hours from the flooding of the water treatment plant, there was enough potable water to provide everyone with about 2 gallons of water per day at more than

100 water supply sites located in Des Moines schools, shopping centers and

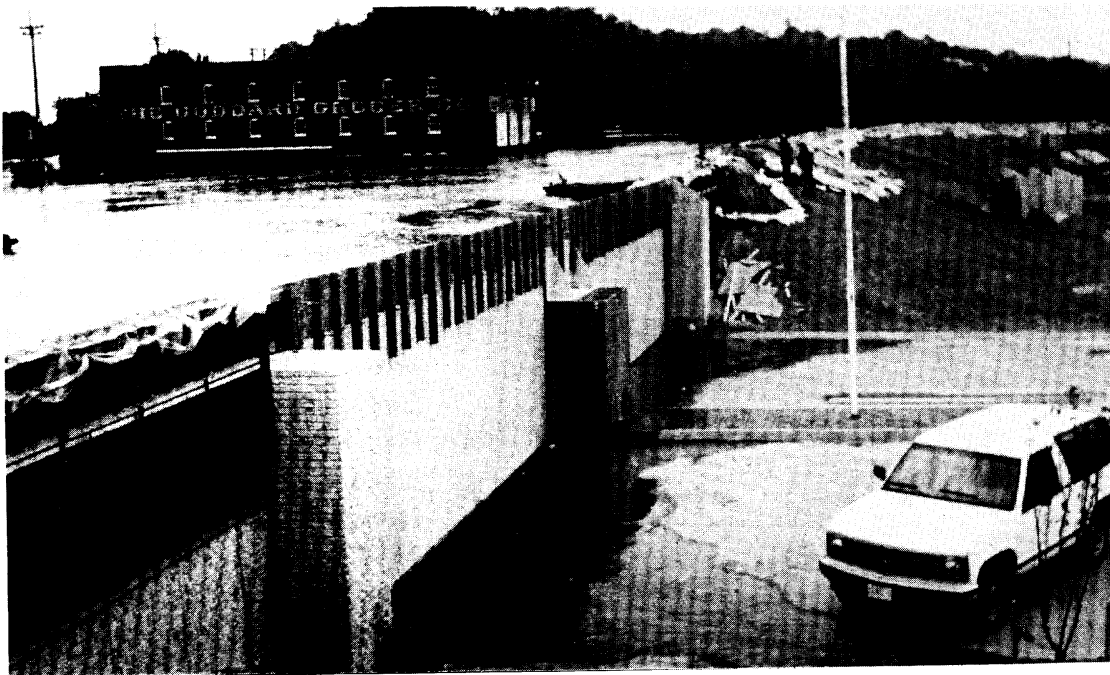


Figure 6. 3-foot addition to Hannibal Project

community centers. Contracts were awarded to provide an additional 500,000 gallons of bottled water per day; tankers of non-potable water for fire fighting; water purification units; and, 2,000 portable toilets for use at the distribution sites and other public areas.

Since it was impossible to get to the water treatment plant with ground vehicles, helicopters were used to airlift parts in and out and to bring in sandbags to increase the height of the protective levee. Corps divers checked clear wells for flood damage and cleaned the sedimentation tank. The plant was back on line one week after it had shut down. However, safe drinking water was not possible until July 30.

In summary, the Corps' flood fight kept it from becoming a disaster of even greater proportions. It was estimated that the Corps' flood control projects that were in place at the start of the flood prevented about

\$14 billion in damages.

A 24-hour emergency operations center was set up at the Rock Island District headquarters as well as at field centers in Quincy and Des Moines. Other experts from across the nation were called in to provide the necessary expertise to help local communities fortify their levees. The Corps was there doing all it could to help the local people win their dramatic battles with the tremendous force of this flood.

Strategy for Flood Recovery Efforts

The flood has ended, but our efforts to help the area recover are just beginning. The Corps is authorized by Public Law 84-99 to repair damaged flood control works such as levee systems. We will first prioritize and then repair the levee systems that need immediate attention.

The Corps has the authority to

repair the following categories of levees: federally constructed and maintained by the Corps; federally constructed, but locally maintained, and, non-federally constructed and maintained. Privately constructed levees are not eligible for repairs by the Corps. The Corps is authorized to repair levees to their pre-flood conditions if they meet three conditions: first, a local public sponsor must provide twenty percent of the cost of repairs to a non-federal levee (federal levees are repaired at full federal cost); second, the repairs must have a favorable benefit-cost ratio; and, third, the levee must have met Corps design and engineering standards prior to the flood.

The levee repair tasks, which are underway, are a big project for the Corps, probably lasting well into next year. This work is being funded by a \$5.8 billion disaster aid bill signed by President Clinton. The North Central Division has already initiated action to repair levees at eight sites along the Upper Mississippi River so that they will be ready for next spring's melt and rains. The Corps will also assess the flood's impact on our environmental management projects, including the fishery habitats.

Interagency Coordination

Interagency coordination between the Corps, Federal Emergency Management Agency, Office of Management and Budget, Environmental Protection Agency, Department of Interior, Department of Commerce, Small Business Administration, and Department of Transportation is an essential part of this levee repair strategy and other flood recovery efforts. Several policy issues are being addressed. These are related to the environment, cost



Figure 7. Flooded control house, Lock and Dam 21

sharing, eligibility, dewatering, deliberate levee cuts during future floods, secondary levees, retention of flood fight measures, and engineering and maintenance guidelines. Priorities for levee repair are taking into account factors such as population centers, major industrial areas, transportation routes and large agricultural areas. A levee rehab policy will be produced as part of the Corps' task. This includes consideration for non-structural alternatives, which will be used if they are acceptable to the local sponsors.

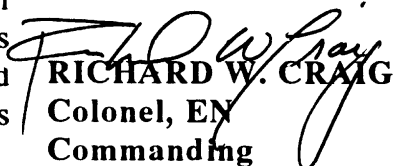
This is not just a story of levees and dams and flooded homes, it is a story of people. The Corps staff responded immediately, many leaving their families and rushing to make themselves available wherever they were needed. As usual, there was no shortage of volunteers as our calls to other Corps offices were immediately answered. They responded to the challenge and did a

great job. Also impressive were the thousands of volunteers who came from all over the nation to help out. They filled sandbags and performed all kinds of other duties, including clean-up and medical treatment and cooking to feed workers, to name just a few. And, of course, there was a tremendous spirit displayed by the local people. It was shown all over the national and international news media. They fought this flood with everything they had and in some cases they won.

So that's the story of the Great Flood of 1993. Because of its close proximity to the Great Lakes basin, we thought you would be interested in learning about the record high water levels and severe flooding conditions on our neighbor watershed, the Upper Mississippi River basin. We trust that it has provided some insight to what could have happened in the Great Lakes basin also.

Milestones

I draw your attention to the fact that this is the 100th edition of the Lake Levels newsletter. We have been continuously producing this newsletter each month since the summer of 1985. It started as an addition to the Bulletin to help further explain the Great Lakes high level conditions at that time and what the public could do to protect itself. It has since served as a means of informing and educating the public about the history, facts, concerns, and issues relating to the Great Lakes basin. We take this occasion to salute you and thank you for your continued interest.


RICHARD W. CRAIG
Colonel, EN
Commanding